New Forms of Work Organization, Skills and Training

by
Craig Eschuk
July 2003

Canada
SP-580-08-03E

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Final Report

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Applied Research Branch
Strategic Policy
Human Resources Development Canada

July 2003

SP-580-08-03E
(également disponible en français)

104-03288/

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This paper is available in French under the title *Nouvelles formes d'organisation du travail, compétences et formation.*
La version française du présent document est disponible sous le titre *Nouvelles formes d'organisation du travail, compétences et formation.*

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Paper
ISBN: 0-662-34915-6
Cat. No.: RH63-1/580-08-03E

PDF
ISBN: 0-662-34916-4
Cat. No.: RH63-1/580-08-03E-PDF

HTML
ISBN: 0-662-34917-2
Cat. No.: RH63-1/580-08-03E-HTML

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Acknowledgements

For comments and suggestions on earlier drafts, thanks to David Wallace, Gilles Bérubé, Benoit Delage and other members of the Workplace, Skills and Productivity Group of the Applied Research Branch of HRDC and to Nicole Fortin, Daniel Parent and Richard Chaykowski.

Abstract

This study addresses the issue of how new forms of work organization (NFWO) are affecting job skill requirements. Practices such as job rotation, problem-solving teams and self-directed workgroups are thought to increase job skill requirements because they tend to broaden job responsibilities. The study uses the 1999 and 2000 waves of the Workplace Employee Survey (WES) to examine how participation in these three new forms of work organization affects skills needs.

As with studies from other countries, this study suggests that these new forms of work organization do lead to new job skill requirements. Moreover, to some extent firms use training to meet the increased skill needs associated with these practices. It is also likely that firms make greater use of existing skills possessed by their employees or to some extent forsake training, because it is too costly. It is also found that employees reporting increased technological complexity since the start of the job are much more likely to have increased skill requirements. This suggests that "more complex," often computer-based, technologies tend to eliminate routine tasks from jobs and introduce more cognitively demanding tasks.

Given this tendency, the principal issues for public policy are to what extent the use and benefits of NFWO are limited by skill deficiencies amongst segments of the working population and to what extent the introduction of NFWO may limit the labour market prospects of individuals without a post-secondary education.

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1. Introduction

For over two decades now, firms in Canada and in other industrialized countries have been attempting to reorganize their workplaces to improve flexibility and performance (OECD, 1999, Osterman, 2000). Efforts have been underway to develop more team working, flatten hierarchies (reduce managerial levels), facilitate more horizontal communication and coordination, develop closer links with clients both within and outside the firm, increase employee involvement in identifying and solving problems, increase the ability of employees to do a multiplicity of tasks and implement a variety of quality management techniques. With these new forms of work organization (NFWO), firms are placing greater responsibilities on their employees to make decisions, to solve problems, to communicate with their co-workers and customers, and to generally engage in a greater variety of tasks (Caroli, 2001). The result for many employees is likely to be new and perhaps greater job skill requirements.

The issue of the impact of NFWO on skills is important because insofar as NFWO do lead to new skill demands, the use and benefits of NFWO might be limited by skill shortages amongst certain segments of the working population. Furthermore, the increasing use of NFWO might also diminish the labour market prospects of individuals with no post-secondary education. It is these individuals that are less likely to have the communication, teamwork, and problem-solving skills that are often associated with firms that make heavy use of NFWO.[1]

This study uses the 1999 and 2000 waves of Statistics Canada's *Workplace Employee Survey* (WES) to examine whether employee participation in three new forms of work organization—job rotation, problem-solving teams and self-directed workgroups—is leading to new job skill requirements. WES is a linked survey where both employers and a random sample of up to twelve of their employees are surveyed. This study makes use of employee responses in WES about their level of participation in job rotation, problem-solving teams and self-directed workgroups. These participation levels are related to three different measures of new skill needs: whether job skill requirements have increased since the start of the job, whether the employee has participated in classroom training in the last year and whether the employee has participated in on-the-job training in the last year. In addition to using Canadian data, another unique feather of this study is that is at the employee-level, unlike most previous studies of how the use of NFWO is affecting skills in the workplace. Most previous studies have been at the establishment level: some overall measure of the usage of NFWO in the establishment is related to an overall measure of new skill needs in the establishment, typically participation in training.

The idea that job rotation, problem-solving teams and self-directed workgroups tend to lead to new job skill requirements is based on the fact that participation in these practices broadens job responsibilities. Since job rotation involves employees exchanging tasks

[1] Adams and McQuillan (2000) find that managers in chemical production, transportation equipment manufacturing and health services in Southwestern Ontario are increasingly seeking "new" skills from their workers, including greater literacy, communication, teamwork skills and the ability to learn. Many of these organizations also had been doing some kind of organizational restructuring.

with one another, there is more overlap amongst employees in the range of tasks that they do. The use of problem-solving teams can add problem-identification, problem-solving and communication tasks to jobs. Participation in problem-solving teams sometimes also involves the use of certain quality management techniques (Hackman and Wageman, 2000; Easton and Jarrell, 2000).[2] For many jobs, the addition of these thinking and interpersonal tasks has the potential to significantly raise skill requirements, but this will depend on how active the employee is in the team and the nature of the problems being tackled.[3]

Sometimes self-directed workgroups *can* act as problem-solving teams, but they broaden job responsibilities in other ways. Participants in self-directed workgroups often have a range of responsibilities that, depending on the nature of the job, include various kinds of production support: housekeeping, the monitoring, coordinating and planning of production and equipment repairs. Team members may take joint responsibility for these tasks. Moreover, there is often an element of job rotation amongst the team members in relation to the various tasks that the self-directed workgroup as a whole must perform.[4]

Participation in these work practices broadens job responsibilities to include new types of tasks, but this does not necessarily appreciably increase skill requirements. New skill requirements may be minimal if new tasks do not differ greatly from ones already performed. Additional tasks may involve new procedures, but essentially use the same skills as before. This would be true, for example, with job rotation if employees are simply exchanging highly repetitive tasks, as on an assembly line. Although each assembly line job requires a different sequence of bodily movements, the skill requirements may not appreciably differ between the rotated jobs.[5]

The study is organized in the following fashion. The first section is an overview of the existing empirical literature on how NFWO are changing skill needs. Following this overview is a descriptive analysis of participation rates in job rotation, problem-solving teams and self-directed workgroups across various occupational groups in 1999. The following three sections are the econometric portion of the study. The first section examines the association between participation in job rotation, in problem-solving teams and in self-directed workgroups and whether the skill requirements have increased since the start of the job. The second section examines the association between participation in these three practices and enrolment in employer-provided classroom and on-the-job training. The first and second sections of the econometric portion use only the 1999 wave of WES. The third section uses the 1999 and 2000 waves of WES to test whether individuals that newly participate in a work practice in 2000 are more likely to have enrolled in training in 2000, compared to individuals that participated in the work practice in both 1999 and 2000. Concluding remarks follow.

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[2] Employers use problem-solving teams to tackle specific problems related to, for example, cost reduction, product quality improvement and the implementation of new processes.

[3] WES also queries about worker-management committees. These can act like problem-solving teams. However, they might rather be vehicles for more downward communication, for the discussion of grievances, or for ways to improve the work environment, rather than to discuss how to improve the work process. In any case, they are likely to involve less autonomy than problem-solving teams.

[4] Appelbaum and Batt (1994) provide an extensive overview of new forms of work organization.

[5] Rinehart and Huxley (1997) make this argument in their case study of a Japanese automobile transplant in Canada.

2. *An Overview of Existing Empirical Research*

There is a growing empirical literature on the question of whether NFWO are creating new skill needs, using data from the U.S. and some European countries. Some of these studies attempt to link the use of specific practices like job rotation, problem-solving teams, self-directed workgroups and total quality management at the establishment-level, to the percentage of employees receiving training or to the employer's evaluation of how skill needs are changing in the establishment. Other studies use instead an index measuring the use of various advanced work practices in the establishment, and relate this to training or to the employer's evaluation of how skill needs are changing. Generally, the establishment-level studies reviewed below do support the claim that the implementation of NFWO are creating new skill needs. Positive relationships are found between either participation in training or various measures of increasing skill needs in the establishment and the use of problem-solving teams, the use of total quality management, the implementation of managerial delayering, as well as various indexes of the use of NFWO in the establishment. These studies find no evidence that the use of job rotation is associated with increased participation in formal training in the establishment. The evidence for self-directed workgroups is somewhat mixed.

2.1 Studies of Job Rotation, Problem-Solving Teams and Self-Directed Workgroups and New Skill Needs

A number of U.S. studies have specifically examined how establishment use of job rotation, problem-solving teams and self-directed workgroups is associated with new skill needs in the establishment.

Using a 1992 survey of 875 U.S. establishments with 50 or more employees, Osterman (1995) finds that the percentage of workers in problem-solving teams (quality circles) is positively related to the percentage of core workers receiving formal training. Core workers are defined in the study as the largest group of non-managerial, non-supervisory workers directly involved in making the product or service in the company—for example, computer programmers in a software firm.[6]

A larger number of studies examine how the use of self-directed or self-managed workgroups is associated with new skill needs. Osterman (1995) finds no relation between the percent of core workers in self-directed teams and the percent of core workers receiving formal training. Lynch and Black (1998) also find no relation between the proportion of workers in self-managed teams and the proportion of workers receiving formal training with their sample of 628 non-manufacturing establishments. However, using their sample of 892 manufacturing establishments, Lynch and Black find that the proportion of

[6] Green, Felstead and Gallie (2000) also present some evidence from Britain that increased participation in problem-solving teams (quality circles) is associated with higher skill requirements.

workers in self-managed teams is positively associated with formal training. Both the non-manufacturing and manufacturing samples in the Lynch and Black study come from the 1994 *Educational Quality of Workforce National Employers Survey* (EQW-NES) of U.S. private establishments with over 20 employees.

In an earlier study using all 2,945 available observations from the EQW-NES,[7] Cappelli (1996) finds no relation between the percentage of employees in self-managed teams and the employer's perception of whether skill requirements have risen for production workers over the previous three years.

These three U.S. studies find no evidence that the use of job rotation is positively associated with formal training. Osterman (1995) actually finds a negative relation between the percentage of core workers participating in job rotation and those taking formal training. By contrast, Black and Lynch (1998) find no relation between the percentage of workers in job rotation and the percentage of workers receiving formal training. It is possible that much training for job rotation may be more informal training, instead of formal training.

In another study of interest, Leigh and Gifford (1999) use the 1993 wave of the U.S. *National Longitudinal Survey of Youth* (NLSY) to examine the extent to which work teams as well as several other factors are creating new skill requirements (the oldest persons are about 37 years old in the 1993 wave of the NLSY). Their sample of 5,971 individuals includes young workers in all industries and occupations that are in the private sector and not self-employed. Forty percent of respondents indicate that there was a change at work in the past 12 months requiring them to learn new job skills and 34% of these employees (or about 14% of all employees) indicate that this was partly due to the creation of work teams. However, this study makes no distinction about whether these work teams are problem-solving teams, self-directed workgroups or some other type of work team.[8]

2.2 Other Studies of New Forms of Work Organization and New Skill Needs

In a study using a sample of over 3,000 U.S. manufacturing establishments with ten employees or more, Gale, Wojan and Olmsted (2002) find a strong link between their index of work organization and rising skill requirements for production workers. Unlike other studies, this one has the advantage of analyzing the association between work organization and changing requirements for specific skill-types: reading, math, problem-solving,

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[7] Lynch and Black (1998) use a smaller number of observations in order to include a capital to labour ratio in the regression model, which was only available for some of the observed establishments. For manufacturing only, the capital to labour ratio has a positive relationship with the proportion of workers trained.

[8] Other important reasons for having to learn new job skills include new equipment or repair procedures (53%), new products or services (45%), the need to upgrade computer skills (39%), changes in compensation policy (28%) and new government regulations (26%)—all percentages in brackets refer to the proportion out of the 40% of employees registering any change requiring them to learn new skills. Of this 40%, 31% say that they learned these new skills from classes or seminars, 70% from coworkers or a supervisor, 42% from self-study materials and 28% on their own

interpersonal, computer and other technical skills. For each skill type, they use an ordered probit model where the dependent variable is the employer's perception of the change in skill requirements—decreased, stayed the same, increased a little and increased a lot—over the previous three years. To measure work organization, the authors use an index for the number of practices—self-directed work teams, job rotation, problem-solving teams, total quality management and statistical process control—that involve over 50% of production employees. They also utilize an analogous index for the number of technologies—four computerized manufacturing technologies in addition to local area networks—that are used by over 50% of production employees.

They find that the work organization index and the computer technology index are positively associated with an increase in skill requirements over the previous three years for each of their skill-types. However, compared to computerized technology which has a large impact only on computer skills, the work organization index is more closely associated with substantial increases across a broader range of skills, especially problem-solving and interpersonal skills and to a lesser extent, computer and technical skills.[9]

Bresnahan, Brynjolfsson and Hitt (2002) use a sample of 300 large U.S. firms. The authors surveyed human resource managers in these firms about the extent of the use in the typical establishment of self-managed teams, quality circles (employee involvement groups), team-building activities and team work as part of promotion criterion and the extent in the typical establishment to which individuals decide on the pace of work. They find that an index of these items is positively related to an index for human capital investment. The human capital index is based on three items: the importance of screening in hiring, the fraction of workers receiving training and the importance of cross-training.

Caroli and Van Reenen (2001) examine the relationship between organizational change and changing skill structure using surveys from both Britain and France. They use the 1984 British *Workplace Industrial Relations Survey* of over 2000 establishments. In this survey, management was asked about the existence of substantial organizational change not involving new equipment over the previous three years and affecting the jobs or working practices for manual workers and non-manual workers. They find that such organizational change for either manual or non-manual workers occurring between 1981-1984 predicts lower relative demand for unskilled labour in 1984-1989. They also use the French Relations Professionnelles et Négociations d'Entreprise Survey of 2500 establishments. They find that firms that delayered their organizations—removed managerial levels—or were in the process of delayering it as of 1992, had lower relative demand for unskilled labour over the 1992-1996 period, compared to 1989-1992.

The Osterman (1995), Black and Lynch (1998) and Cappelli (1996) studies discussed above also examine the association between Total Quality Management (TQM) programs and new skill requirements. Participation in a TQM program may involve participation in a problem-solving team, the use of statistical process control techniques and generally the broadening of responsibilities to include greater involvement in identifying and solving

[9] They also find that for all skill-types except math, the coefficient on the interaction of the technology and work organization indexes is negative, suggesting that computerized technology and advanced work organization are substitutes in their effects on changes in skill requirements.

problems. One consistent finding from these three U.S. studies is a positive relation between total quality management (TQM) and new skill needs. Osterman (1995) finds that the percentage of the establishment's core workers in TQM and the percentage of core workers using statistical process control (sometimes a part of TQM) were both positively related to the fraction of core workers in formal off-the-job training. Lynch and Black (1998) find that the presence of a formal TQM program has a positive relationship with the number of workers receiving training for both manufacturing and non-manufacturing establishments. Cappelli (1996) finds that the presence of a TQM program is positively related to employers reporting rising skill requirements for production jobs.[10]

[10] Also using U.S. data, Frazis, Gittleman and Joyce (2000) find that an index for number practices—including teams, job rotation, TQM and just-in-time inventories—used in the establishment is positively related to employees ever receiving formal training from their current employer. Whitfield (2000) provides evidence from Britain that the use of high performance work practices is positively associated with training in establishments.

3. The Data

The data used for this study is based on *Workplace Employee Survey* (WES), which is a linked survey where both employers and a random sample of up to twelve of their employees are surveyed. The target population for employers are all locations in Canada that have paid employees in March of the survey year, except the following: public administration; religious organizations; road, bridge and highway maintenance; crop and animal production; fishing, hunting and trapping; and private households. In addition, the target population excludes employers in Canada's three territories—Yukon, Nunavut and the Northwest Territories. The target population for the employee portion includes all employees working or on paid leave in March of the selected employers who receive a Canada Customs and Revenue Agency T-4 Supplementary form (Statistics Canada, 2001).

At the time of writing two years of WES were available, 1999 and 2000. The 2000 wave simply re-interviews the locations and employees randomly selected for inclusion in the survey in 1999. Thus, the 2000 wave of WES does not take into account new employees in the location since the initial sample of employees was drawn from the payroll list of the location in March 1999. This makes the 1999 wave more representative of the target population. In 1999, there were 6,322 workplaces and 23,540 employees in the sample; and in 2000, there were 6,068 workplaces in the sample and 20,167 employees. The number of workplaces is smaller in 2000 than in 1999, as a result of workplace deaths. The number of individuals surveyed in 2000 is smaller, because some individuals could either not be contacted or refused to answer the questionnaire.

For locations with over ten employees, WES asks analogous questions of employees and employers about job rotation, problem-solving teams and self-directed workgroups.[11] See Appendix 1 for the employee and employer questions on these three practices. The survey asks employees about their participation level in these practices. For problem-solving teams and self-directed workgroups, there are four levels of participation—never, occasionally, frequently and always. For job rotation, there are three levels of participation—never, occasionally and frequently. For employers, the survey asks whether these practices "exist on a formal basis" in the workplace for non-managerial employees. The definitions of problem-solving teams and self-directed workgroups are quite similar between the employee and employer surveys. However, while the survey asks employees only about job rotation, it asks employers about flexible job design, which is defined to include job enrichment or redesign in addition to job rotation.[12]

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[11] For locations with ten or less employees, the employee and employer questionnaires skip these questions on workplace practices.

[12] Another difference is that while the survey asks employees about their participation in both the 1999 and 2000 waves, it only asks employers about these practices in the 1999 wave. WES asks employers about the existence of job rotation, problem-solving teams and self-directed workgroups again in the 2001 wave. These questions are skipped on the employer survey every second year in order to ease the burden on respondents.

4. *The Incidence of Job Rotation, Problem-Solving Teams and Self-Directed Workgroups across Occupations*

Table 1 shows the proportion of employees in 1999 participating in job rotation, problem-solving teams and self-directed workgroups by various occupations in locations with over 10 employees.[13] Blue-collar occupations are broken down into manufacturing and non-manufacturing industries. There are separate percentages for employees that occasionally participate, for employees that frequently or always participate and for employees that have any participation (occasionally, frequently, or always). Table 1 also distinguishes between participation rates in "formal practices" and "informal practices." However for managerial employees, the questions on work organization in the employer questionnaire are specifically addressed toward non-managerial employees (Appendix 1), so there is no distinction made between informal and formal versions of the practices for these workers. A substantial number of non-managerial employees say that they participate in job rotation, problem-solving teams and self-directed workgroups even though their employer says that the corresponding practice does *not* "exist on a formal basis" for non-managerial employees in their workplace. Undoubtedly, part of this apparent discrepancy is reporting error on either the employee or the employer side. In some cases, the respondent for the employer may not know what work practices are being used in the workplace. Much of the discrepancy, however, likely stems from the fact that WES only asks employers whether the practice exists on a *formal basis* in their workplace. Even though a practice may not be establishment policy, it still may exist on a more informal basis, more at the discretion of the participants in the practice and their immediate supervisors. For the purposes of this study, "informal practice" refers to when employees participate in a practice that does *not* exist on a formal basis in the location. Conversely, a practice is considered "formal" when it does exist on a formal basis.[14]

One notable feature of Table 1 is the high rate of participation in self-directed workgroups that do *not* formally exist in the workplace. The overall participation rate is high, at least three times as great as in self-directed workgroups that formally exist in the workplace and higher than participation in formal and informal job rotation and problem-solving teams. Compared to job rotation and problem-solving

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[13] Table 1 omits occupations in social science, education and religion (National Occupation Classification-E) in art, culture, recreation and sport (NOC-F) and some service occupations like food service, child care, cleaners and their supervisors (parts of NOC-G). Job rotation, problem-solving teams and self-directed workgroups are either not that relevant or nothing new for occupations like social scientists, teachers, ministers, actors, photographers, coaches, athletes, cooks, child care workers and so forth.

[14] Table 1 only presents participation rates for 1999. The 2000 wave of WES is based on the 1999 sample and does not take into account new employees in the location since the initial sample of employees was drawn sometime in 1999. Thus, participation rates for 2000 would be restricted to employees who worked for the same employer at the time of both their 1999 and 2000 interviews. Two years is also not long enough to establish a trend in participation in these practices.

teams, self-directed workgroups would appear to be the least likely to exist on an informal basis, since there is a probable need for significant work reorganization including some decentralization of responsibility when they are implemented. It is likely that respondents are interpreting the question a bit more loosely than was intended, to include a somewhat broader range of workgroups than self-directed ones. This possibility is suggested in the question on self-directed workgroups in WES, which effectively describes them as work groups with a "high level of responsibility for a particular product or service area" (Appendix I). The managerial vantage point may lend itself to a narrower definition of a "high level of responsibility," and thus a stricter definition of what kind of workgroup constitutes a self-directed one. The employer may also be more familiar with the notion of a self-directed workgroup, also leading to a stricter definition. Employees who say that they are part of a self-directed workgroup are evidently referring to some kind of work group or work crew to which they belong. However, these workgroups may not be of the self-directed kind, where individuals have a broad set of responsibilities and there is a high degree of self-management at the individual and group level. The questions on job rotation and problem-solving teams are much more specific and do not lend themselves to such problems of interpretation.

Thirty percent or more of employees in all occupations except sales and cashier occupations report participating in a problem-solving team at least occasionally, with a greater proportion participating in the informal version. Only 20% of employees in sales and cashier occupations report participating in a problem-solving team. Employees in science and health care occupations and in managerial and professional business occupations report the highest participation in problem-solving teams of all occupational groups—48% and 55%, respectively. These relatively high rates of participation suggest that the skills required for problem-solving teams will be quite widespread throughout the economy.

Participation rates in job-rotation are somewhat lower than in problem-solving teams, especially participation in the formal version of the practice. Shop-floor employees have the highest rate of participation in job rotation, at 30% of employees. Sales and cashier employees report the lowest rate of participation, at 13% of employees.

The following econometric part of this study will focus on the shop-floor, office (clerical and administration), and science and health occupational groups. Together, these three occupational groups account for 34% of the WES employee target population (Table 1). It is important to treat these occupational groups separately, because of possible heterogeneity in the relationship between participation in these workplace practices and our measures of new skill needs. For one, the tasks associated with these practices may be more substantial and have greater skill requirements between different work contexts. Secondly, the effect that these tasks have on skill requirements will depend on the skills the employee is already using on the job. It is possible, for instance, that the introduction of problem-solving teams and self-directed workgroups in particular may create a greater jump in skill requirements for shop-floor and office employees than for the more professional health and science employees, relative to existing skill requirements. For shop-floor and office employees, problem-solving teams and self-directed workgroups may introduce skills (i.e., communication and problem-solving skills) into the jobs that previously did not make substantial use of these skills.

5. Is Participation in Job Rotation, Problem-Solving Teams and Self-Directed Workgroups Associated with Increased Skill Requirements?

WES asks employees about the change in their job skill requirements, "Since you began working in your current job, have the overall skill requirements of the position: increased, stayed the same or decreased?" In 1999, 45% of shop-floor employees, 64% of office employees and 63% of science and health employees said that their skill requirements had increased since the start of their job. Only 2%, 3% and 0.4% of these employees, respectively, reported that their skill requirements had decreased.

5.1 An Empirical Model of Changes in Skill Requirements

We can test whether participation in job rotation, problem-solving teams and self-directed workgroups is associated with increased skill requirements since the start of the job using the following model:

$$Skill_Change_i^* = \alpha_i + \beta_1 Part_i + \beta_2 Org_i + \beta_3 Tech_i + \beta_4 X_i + \varepsilon \qquad (1)$$

where for individual i, $Skill_Change_i^*$ is a latent variable measuring the difference between current job skill (human capital) requirements and job skill requirements at the start of the job; $Part_i$ is a vector of participation levels in job rotation, problem-solving teams and self-directed workgroups; Org_i is a vector of dummies for employees working in locations where flexible job design, problem-solving teams and self-directed workgroups formally exist; $Tech_i$ is a vector of controls for changes in technology and technological usage; and X_i is a vector of controls for job, employee and firm characteristics. This model is estimated separately for each of the three occupational groups: shop-floor, office, and health and science employees.

Since our measure of skill change is categorical and there are few responses of skill requirements having decreased, we can use a binary dependent variable to estimate the model (equal to one if skill requirements have increased since the start of the job and zero otherwise). One limitation of this binary measure of change in skill requirements is that the significance of the increase in skill requirements is not taken into account. Presumably however, the increase in skill requirements must be above some threshold. If the task of sweeping the floor is added to a job, the person holding it is unlikely to say that the skill requirements of the job have increased. The same is true for new tasks that require substantially the same skills as before, but involve somewhat different procedures. Increases in skill requirements that are small are also more likely to be forgotten by employees.

For job rotation and problem-solving teams, the model includes separate variables for employee participation in the formal and in the informal versions. There are likely to be differences in how job rotation and problem-solving teams are used between locations where these practices exist on a formal basis and where they do not exist on a formal basis. Practices that exist on a formal basis may involve greater responsibilities and hence more likely to increase job skill requirements. The job rotation and problem-solving team variables take the value of one when respondents occasionally participate and two when respondents frequently participate.

As discussed above, employees who say that they do participate in a self-directed workgroup may have in mind a somewhat looser definition of a self-directed workgroup than was originally meant by the question and in the literature on self-directed workgroups. Unlike the other two work practices, the model does not include a variable for participation in informal self-directed workgroups (i.e., where self-directed workgroups do *not* "formally exist" in the location). Participation in self-directed workgroups in locations where they "formally exist" is likely to be more precisely measured because in such locations employees will likely have a clearer idea about what self-directed workgroups are. This variable for self-directed workgroups gives a value of one if respondents occasionally participate, two if they frequently participate, and three if they always participate.

If the tasks associated with a work practice have not substantially changed since the start of the job, we would not expect to observe any correlation between participation in the work practice and our measure of increased skill requirements. Hence, it would be best to have a measure of the change in job tasks due to participation in these work practices, instead of the level of participation in each of the practices. However, because of entrance into and greater involvement in each of these work practices, the level of participation will be positively related to increases in the diversity and complexity of tasks since the start of the job. Moreover, even if there has been no change in the level of participation since the start of the job, as the worker gains experience, more demanding tasks may be introduced, thereby increasing skill requirements. This may be especially true of problem-solving teams, as the team tackles new problems or uses new techniques to solve existing problems.

The vector of technology variables, $Tech_i$, includes a variable for the change in technological complexity. It is based on the question, "Since you started this job, has the overall technological complexity remained about the same, increased, or decreased?" The percentage of employees that report a decrease in technological complexity is small; 1.6% of shop-floor employees, 1.5% of office employees, and 0.7% of health and science employees in 1999. Consequently, the model does not control for decreases in technological complexity. The model also includes separate dummies for whether the employee uses a computer (i.e., a personal computer, mainframe, etc.), for whether the employee uses computer-controlled or computer-assisted technology, and for whether the employee uses "any other machine or technological device for at least one hour a day in the course of...normal duties."

The technologies, techniques and procedures used in production and how their uses are allocated between workers in the organization are the proximate factors that determine job skill requirements. Changes in these proximate factors lead to changes in job tasks and sometimes in skill requirements if these task changes are great enough. The extent to which the proximate factors affecting skill requirements change and how these changes also lead to changes in skill requirements, if at all, will vary according to a number of job, employee and firm characteristics. These are represented in the equation (1) by the vector X_i. The vector X_i includes dummies for the following job- and employee-related characteristics: occupation, job tenure (up to the cubic level), part-time jobs (except for shop-floor employees[15]), casual, term or seasonal jobs, coverage by a collective bargaining agreement or union membership, education, and gender.

The inclusion of fairly detailed occupational dummies is important because different occupations face different rates of technological change. There are also differences in self-learning and training in jobs between different occupations that will affect changes in skill requirements. Firms will modify the job responsibilities of their employees to include tasks that take advantage of their greater proficiency, without necessarily moving the employee into another job. For some occupations, opportunities for learning are greater than others, especially in occupations with more complex and less routine tasks. The models for shop-floor, office, and science and health employees control, respectively, for 26, 32 and 18 occupational categories. Part-time jobs will be less likely to experience a change in skill requirements, because such workers often have fewer task responsibilities and thereby less likelihood of any changes in responsibilities. The model includes a dummy for contingent employment (a casual, term or seasonal job), because they are less likely to get the training that is often needed to make an increase in skill requirements effective. Unions can also affect skill requirements through collectively bargained work rules. Dummies for education are in the model for the same reason as occupational dummies, to control for differences in skill level. Gender may affect the propensity to take training which may be necessary to make an increase in skill requirements effective. Gender may also be related to certain occupational characteristics; for example, on the shop-floor, males may be more likely to occupy more highly skilled jobs.

The vector X_i also includes a number of location characteristics: location size dummies (based on the number of employees), a dummy for being part of a multi-establishment enterprise and industry dummies. These will help control for managerial factors, which may have both a causal effect on the changing skill requirement in the establishment and the use of job rotation, problem-solving teams and self-directed workgroups. The model includes these independent variables because different enterprises face different market conditions and opportunities, have different resources to implement change and have different kinds of managerial and firm cultures. See Appendix III for definitions of selected independent variables.

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[15] Less than one percent of shop-floor employees say that they work 30 hours or less per week, the definition of a part-time employee here.

At the time of writing, two waves of WES, 1999 and 2000, were available. The 2000 wave is less representative than the 1999 wave, sampling only employees who were at their employer at the time of both their 1999 and 2000 interviews and not, as with the 1999 wave, all employees. For this reason, the model is estimated using the 1999 wave only. Because the sample is different, use of the 2000 wave may lead to some different results than with the 1999 wave if there is heterogeneity between different groups of workers or heterogeneity across time.[16]

The model is estimated using logistic regression, with standard errors calculated using the bootstrap weights that accompany the WES data set. Bootstrapping will adjust for survey design effects, in particular clustering effects whereby the outcomes for employees within the same location are related to one another. Table 2 shows the coefficients and standard errors of the estimates for the three occupational groups (shop-floor, office, and science and health employees). Table 3 contains estimates of the probability of increased skill requirements associated with different values of selected independent variables. These probabilities are calculated at the weighted means of the independent variables. The means of the variables in the model for the three occupational groups are in Appendix IV.

5.2 The Results

Participation in both formal and informal problem-solving teams is positively associated with increased skill requirements for all three occupations—shop-floor, office and science and health occupations (Table 2). The difference between not participating in a formal problem-solving team and frequently participating is to raise the probability of reporting increased skill requirements from 44% to 57% for shop-floor employees, from 62% to 76% for office employees, and from 67% to 74% for health and science employees (Table 3). This represents a 30%, 23% and 10% increase in the probability, respectively. Frequent participation in informal problem-solving teams raises the probability of increased skill requirements from 37% to 46% for shop-floor employees, from 62% to 69% for office employees, and from 67% to 74% for science and health employees. This represents a 24%, 12% and 11% increase in the probability, respectively. The skill requirements of shop-floor employees appear to be the most affected by participation in problem-solving teams and the skill requirements of science and health employees the least affected.

Participation in job-rotation has a positive relationship with increased skill requirements for office and for science and health employees only (Tables 2 and 3). The effect is particularly strong where the location formally supports flexible job design (i.e., formal job rotation). Going from none to frequent participation in formal job rotation raises the probability of increased skill requirements from 64% to 81% in the office and from 68% to 85% for science and health occupations. Evidently, the new tasks introduced by job rotation on the shop-floor require much the same skills as the old tasks, although routines may be a bit different.

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[16] An unobserved effects model might be appropriate if the dependent variable was whether skill requirements have increased *during the previous year*, instead of whether they have increased *since the start of the job*. As it stands the dependent variable does not lend itself to an unobserved effects model.

There is also evidence that participation in a self-directed workgroup (where the location says it is formally supported) is positively associated with increased skill requirements for shop-floor and for office employees, but not for science and health occupations. This supports the claim that self-directed workgroups tend to have a greater positive effect on skill requirements for less-skilled jobs.

An increase in technological complexity since the start of the job raises the probability of increased skill requirements from 30% to 59% for shop-floor employees, from 49% to 73% for office employees, and from 47% to 76% for science and health employees. All are substantial increases. These more complex technologies do not simply tend to increase skill requirements because greater skill is required to operate the new technologies. Rather, and perhaps more importantly, the more complex technology, particularly computer-based technology, enables the job to be restructured so as to eliminate many routine tasks and introduce more highly cognitive tasks into the job. Usage of computer by shop-floor and office employees is also positively related to increased skill requirements, as is usage of "other device" for all three occupational groups.

Shop-floor employees in locations that formally support problem-solving teams are more likely to report that their skill requirements have increased since the start of their job. Perhaps manufacturing locations that formally support problem-solving teams are more inclined to improve and modify their production processes, generating increases in skill requirements. Participation in problem-solving teams by production employees likely depends on the extent to which employers are trying to improve or modify their production processes.

For shop-floor employees, having a collective bargaining agreement or being a union member reduces the likelihood of increased skill requirements. This may stem from union work rules which can limit employer flexibility to modify the tasks that workers are assigned (job control unionism). The same is not true for office employees or for science and health employees, perhaps reflecting the lesser importance of union work rules in these types of workplaces.

6. Is Participation in Job Rotation, Problem-Solving Teams and Self-Directed Workgroups Associated with Classroom and On-the-Job Training?

If participation in job rotation, problem-solving teams and self-directed workgroups is creating new skill needs, this may be reflected in training. This part of the study uses the 1999 wave of WES to evaluate how participation in job rotation, problem-solving teams and self-directed workgroups is associated with enrolment in employer-provided classroom and on-the-job training. It is possible that these practices do create certain skill needs, such as a need for better communication and problem-solving skills that firms find too costly to impart through training. Thus, not finding any relationship between these practices and training does not imply that they do not generate new skill needs.

6.1 A Model of Training

To test whether participation in job rotation, problem-solving teams and self-directed workgroups is associated with training, we can use the following model:

$$Tr_i^* = \alpha + \beta_1 Part_i + \beta_2 Org_i + \beta_3 Tech_i + \beta_4 X_i + \varepsilon_i \qquad (2)$$

where for every individual i, the dependent variable Tr_i^* is a latent variable measuring the propensity to take employer-provided training; $Part_i$ is a vector of participation levels in job rotation, problem-solving teams and self-directed workgroups; Org_i is a vector of dummies for employees working in locations where flexible job design, problem-solving teams and self-directed workgroups formally exist; $Tech_i$ is a vector of dummies for technological usage and upgrades in technology; and X_i is a vector of other employee, job and firm characteristics. This model is similar to that for increased skill requirements in equation (1) above.

We can estimate the model using a binary variable for whether the employee takes classroom training in the 12 months prior to their interview, as well as using a similar binary variable for on-the-job training. Training is not counted if it is only orientation for new employees, managerial and supervisory, or occupational health and safety and environmental protection. See Appendix II for a description of the training questions in WES. Most new employees will get some orientation training. Job rotation, problem-solving teams and self-directed workgroups cannot be expected to have any appreciable effect on managerial and supervisory training. Health, safety and environmental protection training is to some extent mandated by provincial governments in Canada.

The other explanatory variables in the training models for shop-floor and office employees are the same as in the skill increase models. The exceptions are the inclusion of a variable for age and age squared and some different variables for technology. In the skill increase models, the dummy for an increase in technological complexity is dropped because it applies to the whole job tenure, so does not match the time frame of classroom training (within the last 12 months). The training models include two dummies for technology: an upgrade in the last 12 months in a computer controlled device used by the employee and an upgrade in the last 12 months in a device used by the employee that is not a computer or computer controlled.[17]

As with the estimates for the model of increased skill requirements, standard errors are calculated using the bootstrap weights that accompany the WES data set. Tables 4 and 6 contain the regression results for classroom and on-the-job training, respectively, for the three occupational groups. Tables 5 and 7 contain the estimates of the probability of enrollment in classroom and in on-the-job training, respectively, associated with different values of selected independent variables. Variable means are in Appendix IV.

6.2 Classroom Training

Participation in at least one form of job rotation (formal or informal) is positively related to enrollment in classroom training in the last 12 months for all three occupational groups (Table 4). The difference between not participating in formal job rotation and frequently participating is to raise the probability of enrollment in classroom training from 33% to 51% for office employees and from 54% to 79% for health and science occupations (Table 5). For shop-floor employees, participation in formal job rotation has no effect on classroom training. With frequent participation in informal job rotation, the probability of enrollment in classroom training increases from 13% to 30% for shop-floor employees, from 33% to 41% for office employees and from 43% to 56% for health and science employees.[18]

On the shop-floor, frequent participation in formal and in informal problem-solving teams increases the probability of taking classroom training from 17% to 27% and from 11% to 22%, respectively. For the other two occupational groups, the relationship between participation in a problem-solving team and enrollment in classroom training is a bit weaker, particularly for office employees. For science and health employees, frequent participation in formal problem-solving teams raises the probability of enrollment in classroom training from 45% to 62%. There is no positive relationship with informal problem-solving teams.

There is no evidence that participation in self-directed workgroups is positively related to enrollment in classroom training for any of the three occupational groups. Participation in a self-directed workgroup is even negatively associated with enrollment in classroom

[17] See Frazis, Gittleman and Joyce (2000) and Turcotte, Léonard and Montmarquette (2002) for training studies using linked data sets. See also Osterman (1995).

[18] The base percentage is higher for formal job rotation by science and health employees, because it includes the positive effect on the dummy for employees in locations which formally support flexible job design.

training for shop-floor employees. This negative relationship may reflect other aspects of jobs that participants of self-directed workgroups have, rather than the effect of participation in self-directed workgroups itself. Moreover, as discussed above, there is some concern that responses to the question on self-directed workgroups in WES capture participation in workgroups other than the self-directed kind.

A number of the technology variables are statistically significant: in five of these cases the coefficient is positive and in three cases it is negative. One negative coefficient is, surprisingly, on a dummy for an upgrade in other device (for science and health employees). The corresponding use variable is positive and statistically significant. Evidently, the upgrade dummy is capturing certain types of users of "other devices" that have less classroom training needs.

Many studies that have examined the determinants of employer-supported formal training show that individuals with a higher level of education are more likely to take this kind of training, particularly when comparing post-secondary university or college degree holders with non-degree holders (Frazis, Gittleman and Joyce, 2000; Turcotte, Léonard and Montmarquette, 2002). The estimates on the education dummies paint a more complicated picture. In some cases employees with only a high-school diploma, a vocational diploma, industry certified training or just some college are more likely to take classroom training than employees with a college or university degree, depending on the occupational group. For example, science and health employees with only a high-school degree and no further education (about 11% of the sample) are more likely to take classroom training than employees with a college degree (about 30% the sample). Whether formal education and work-place training are complements or substitutes may depend on the occupation and the nature of the workplace. Moreover, in many studies, educational dummies may be capturing differences in training needs between occupations (even when there are occupational controls).

6.3 On-the-Job Training

Of all the work practice variables, only participation in the informal versions of job rotation and problem-solving is positively related to enrollment in on-the-job training (Tables 6 and 7). Participation in informal job rotation and problem-solving teams is positively associated with on-the-job training for all occupational groups, except for informal problem-solving teams on the shop-floor. Shop-floor participants in formal job rotation actually have a lower likelihood of taking on-the-job training than non-participants. The same is true of office participants in formal problem-solving teams. Why participation in the informal versions of the work practices and not participation in formal versions is positively associated with enrollment in on-the-job training is unclear. It is possible that the on-the-job training that takes place with respect to the formal versions of the work practices is more difficult to recognize as training for employees (Barron, Berger and Black, 1997).

Shop-floor employees that use a computer have a probability of taking on-the-job training of 30% versus 17% when not using a computer (Table 7). An upgrade in a computer device raises the probability of taking on-the-job training from 20% to 30%. For office employees there are also large increases in the probability of taking on-the-job training associated with the usage and upgrading of various technologies. For science and health employees, only the two upgrade variables are statistically significant and both have negative coefficients.

Office workers covered by a collective bargaining agreement are less likely to take on-the-job training, but science and health workers more likely. These relationships may have more to do with the kinds of jobs covered by a collective bargaining agreement than with the effect of the collective bargaining agreement on, on-the-job training.

7. *Does New Participation in Job Rotation, Problem-Solving Teams and Self-Directed Workgroups Lead to Increased Enrollment in Training?*

In the previous section, we evaluated the association between participation in job rotation, problem-solving teams and self-directed workgroups and enrollment in both classroom and on-the-job training. To better assess the causal effect of participation in these work practices on skill needs, it is useful to examine whether employees that are relatively new to one of these work practices are more likely to take training than employees that have been participating in these practices for some time.

We can use both the 1999 and 2000 waves of WES to distinguish between those employees that have participated in these practices for less than a year when surveyed in 2000 (new participants) and those that have participated in them for more than a year when surveyed in 2000 (continuing participants). It is possible that much training which is associated with new participation is actually completed before participation in the practice begins, rather than after. There may be many individuals, for example, that complete all their training in 1999 for participation in a work practice that begins in 2000. For this reason, an unobserved effects (i.e., fixed or random effects) model is inappropriate. To use such a model, we would have to be confident that all additional training, or the vast majority, by employees who newly participate in a work practice in 2000 occurs in 2000.

An alternative modeling strategy is to test whether the variable for new participation in 2000 (i.e., participated less than a year) has a stronger positive association with enrollment in training in 2000 than is the variable for continuing participation (i.e., participated more than a year). If new participation in a work practice has a stronger positive relation to training than continuing participation, then this would suggest that new participation does lead to increased training. Of course, this modeling strategy will not capture the relationship between new participation in 2000 and any training taken in 1999 in anticipation of this participation.

We will estimate a model similar to equation (2). The only difference is that there are now two participation variables for each of the work practices: one variable for employees participating in both 1999 and 2000 (continuing participation) and another variable for employees participating in only 2000 (new participation).

The occupational sub-samples in this section only include employees who were working at the same employer at the time of their 1999 and 2000 interviews and said in the 2000 interview that their job title had not changed since the previous interview. In both years, employees were asked about their occupation and there is some variation in these responses between the two years, despite the fact that these employees said that their job title had not changed. The shop-floor 1999 and 2000 sub-samples exclude employees who

were reported in one of the years to have an occupation in National Occupational Classification categories H, I or J and in the other year an occupational category outside of these (Table 1). The analogous sub-sample restriction is imposed on the sub-samples of office employees and health and science employees. Tables 8 and 9 show the regression results for classroom training and on-the-job training, respectively. Variable means are in Appendix IV.

7.1 Classroom Training

There is *no* evidence that new participation in job rotation, problem-solving teams or self-directed workgroups is more positively associated with enrollment in classroom training than continuing participation (Table 8). In only one instance, with formal job rotation for office employees is the coefficient on new participation more positive than the coefficient on continuing participation and the difference statistically significant (F-Test not shown[19]). In fact, the reverse is true in five cases: the coefficient for continuing participation is more positive than the coefficient for new participation and the difference statistically significant (the F-Tests are not shown). Perhaps, any increased classroom training associated with participation in certain work practices tends to occur sometime after participation has begun, so that training needs and the employee's commitment to their new job duties can be assessed.

The coefficient on new participation in formal problem-solving teams is negative and statistically significant for shop-floor and for science and health employees. The same is true for new participation in informal job rotation for science and health employees. In two of these three instances, the coefficient on the corresponding variable for continuous participation is positive and statistically significant and in the other it is close to zero. The reasons for these negative coefficients are unclear. It is unlikely that new participation in either problem-solving teams or in job rotation would actually reduce training needs.

There are some differences between the results using 2000 data, compared to the results from classroom training regressions for 1999 discussed in the previous section. The relationship between participation in job rotation and enrollment in classroom training is fairly consistent between the two years. However, the relationship between participation in problem-solving teams and enrollment in classroom training for the 2000 sub-sample is somewhat different compared to the 1999 sub-sample for each of the three occupational groups. Participation in informal problem-solving teams is *not* associated with classroom training for shop-floor employees in 2000, but is associated with classroom training in 1999. Participation in problem-solving teams (informal and formal) is much more strongly related to enrollment in classroom training for office employees in 2000, than in 1999. Participation in formal problem-solving teams is positively associated with classroom training for science and health employees in 1999, but *not* in 2000. We still find the same differences when restricting the 1999 sub-sample to those observations used in 2000 (results not shown).

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[19] The F-tests are available from the author.

If changes in job tasks from the introduction of new product lines, technologies or procedures are the primary cause of the link between participation in problem-solving teams and classroom training, there will be more variation in the relationship between participation in problem-solving teams and classroom training from year-to-year than there would be otherwise. Participation in the work practice, particularly problem-solving teams and self-directed workgroups, may have a causal role here insofar as they help facilitate the introduction of these new product lines, techniques and procedures. This interpretation is also consistent with the finding that new participation in problem-solving teams is not more positively related to classroom training than continuing participation.

The same explanation may be partly behind the fact that participation in self-directed workgroups is negatively associated with enrollment in classroom training in 2000 for office workers, while there is no such association in 1999. The fuzzy definition of self-directed workgroups in WES may also be a problem here.

7.2 On-the-Job Training

Similar to classroom training, there is little evidence that new participation in the work practices is more positively associated with enrollment in on-the-job training than is continuing participation (Table 9). Only the coefficient on new participation in informal job rotation for office employees is more positive than the coefficient on continuing participation and the difference statistically significant (F-Test not shown). In five cases the reverse is true where the coefficient on continuing participation is more positive than the coefficient on new participation and the difference statistically significant. Thus, there is no evidence that the introduction of a work practice leads to increased skill needs that in turn leads to increased enrollment in on-the-job training. As noted above, however, there may be response error problems with on-the-job training. Certain types of on-the-job training may be systematically underreported by participants in this training, because it is less obvious to them that it is on-the-job training. This may be true of on-the-job training that essentially involves observing others doing their job, as opposed to a more explicit teaching effort.

As with classroom training, there are differences from year-to-year in the relationship between participation in the work practices and enrollment in on-the-job training. In the 2000 sub-sample, there is a positive relationship between: participation in formal job rotation (for office and science and health employees) and on-the-job training, and participation in formal problem-solving teams (for all three occupational groups) and on-the-job training. There was no evidence of such positive relationships in the 1999 sub-sample. Restricting the 1999 sub-sample to those observations used in 2000 (results not shown), we still find the same differences.

8. Concluding Remarks

The principal aim of this study has been to examine whether job rotation, problem-solving teams and self-directed workgroups are creating new skill needs. We do find substantial evidence that participation in these three work practices is associated with new skill needs, although the strength of this association depends on the specific work practice and the occupational group.

The strongest evidence for this stems from the positive associations we observed between increased skill requirements since the start of the job and participation in problem-solving teams and participation in job rotation. Participation in problem-solving teams is positively associated with increased skill requirements for all occupational groups. The fact that over 30% of employees in all three occupational groups participate in problem-solving teams suggests the overall importance in the economy of the skills required for use in problem-solving teams.

Only for office employees and science and health employees do we find that participation in job rotation is associated with a higher probability of reporting increased skill requirements since the start of the job. For shop-floor employees, there is no evidence that job rotation is positively associated with increased skill requirements since the start of the job. This confirms the contention by some authors that job rotation on the shop-floor tends to have no substantial effect on the job skill requirements (Rinehart and Huxley, 1997).

For shop-floor employees, there is evidence that participation in self-directed workgroups is positively associated with increased skill requirements. This does suggest that individuals working in teams, other than the problem-solving kind, are more likely to experience increased skill requirements. It is unclear to what extent those individuals that say they are working in self-directed workgroups are actually working in one and not in a workgroup that offers somewhat less responsibility to members of the workgroup. There is no evidence for the other two occupational groups of a positive relationship between participation in a self-directed workgroup and increased skill requirements since the start of the job.

We also found evidence of positive associations between participation in job rotation and in problem-solving teams and enrollment in classroom training. The positive relationships for problem-solving teams, however, may stem from the fact that participants in the problem-solving teams are more likely to experience changes in their job tasks other than those related to the introduction of or changes in the work practice itself. This would help explain some of the inconsistencies observed between the 1999 and 2000 results, and the fact that new participation in problem-solving teams is not more positively related to either classroom or on-the-job training compared to continuing participation. It is likely that the increased demand for problem-solving and communication skills required for problem-solving teams in particular is to some extent met by fuller use of existing skills by employees. In fact, one of the rationales of implementing problem-solving teams and self-directed workgroups and other changes in work organization has been to make more effective use of skills that employees already have. Learning may also be done in more informal ways, such as by observing others or learning-by-doing, rather than through teaching.

This study also finds a strong relationship between technological change and new skill requirements. For all three occupational groups, employees reporting increased technological complexity since the start of the job are much more likely to report that their skill requirements have also increased since start of the job. This would suggest that "more complex," often computer-based, technologies tend to eliminate routine tasks from jobs and introduce more cognitively demanding tasks.

As this study shows, both the organizational and technological choices that firms make are important determinants of their skill needs. However, there may be substantial differences in how organizational and technological changes affect the kinds of skills required in the workplace. Although not demonstrated in this study, new technologies may tend to require technical skills rather specific to those technologies, such as learning to use a particular piece of software or operate a computer controlled device. By contrast, many new forms of work organization, as Caroli (2001) emphasizes, often require more general, non-technical skills, such as communication and general problem-solving skills. The study by Gale, Wojan and Olmsted (2002) reviewed earlier provides empirical support for this.

New technological opportunities, in particular information technologies, may be important factors prompting the introduction of new forms of organization (Caroli, 2001). However, non-technical skill requirements may be more likely to arise when new forms of work organization accompany technological change. This points to the continued importance of general skills for education and training policies. It is possible that the lack of such sufficient skills, particularly at low and intermediate skill levels is constraining the use of new forms of work organization and thus any benefits that these practices may have on business performance and working conditions.

According to the literature review and this study, all the evidence to date suggests that the tendency of NFWO has been to increase skill requirements. This stands to reason, since NFWO generally broaden job responsibilities. Further empirical study of the extent to which NFWO are affecting job skill requirements is unlikely to be that helpful for public policy. This is partly because it is so difficult to quantify both organizational change (changes in job responsibilities from the use of new forms of work organization) and changes in skill requirements using survey research methods. It is also because there are other more pertinent issues for public policy. They are the extent to which efforts to introduce NFWO by firms and the benefits of the use of NFWO are limited by skill deficiencies amongst segments of the working population. The other more pertinent issue is the extent to which the growing use of NFWO may be limiting the labour market prospects of individuals with no post-secondary education. The identification of specific kinds of skill shortages faced by organizations that have made substantial use of NFWO would certainly facilitate education and training policy. The existence of these skill shortages may warrant industry- or government-sponsored training or remedial education programs for existing and prospective employees.

List of Tables

Table 1
Participation in job Rotation, problem-solving Teams, and Self-Directed WorkGroups by selected occupations, 1999

	No. of Obs.[b]	Percent of WES Target Pop.	Degree of Participation	Job Rotation		Problem-Solving Teams		Self-Directed Work Groups		National Occupational *Classification*[e]
				Informal[c]	*Formal*[d]	*Informal*	*Formal*	*Informal*	*Formal*	
Blue Collar—Manufacturing (Shop-floor)[a]	2,860	10%	Occasionally	15%	4%	7%	7%	4%	1%	H, I & J in manufacturing
			Freq./Always	8%	3%	15%	11%	31%	8%	
			Any	**23%**	**7%**	**22%**	**17%**	**35%**	**9%**	
Blue Collar—Non-Manufacturing	3,143	8%	Occasionally	10%	2%	9%	4%	10%	7%	H, I & J in non-manufacturing
			Freq./Always	4%	1%	10%	7%	34%	3%	
			Any	**14%**	**3%**	**19%**	**11%**	**45%**	**10%**	
Sales and Cashier Occupations	1,344	9%	Occasionally	6%	2%	7%	3%	4%	1%	G011, G1 to G3
			Freq./Always	4%	2%	7%	3%	23%	2%	
			Any	**9%**	**4%**	**14%**	**6%**	**27%**	**3%**	
Administration / Clerical Occ. (Office)	4,310	14%	Occasionally	14%	6%	10%	6%	6%	1%	B1 to B7, G713-G715
			Freq./Always	4%	2%	9%	7%	27%	7%	
			Any	**18%**	**8%**	**19%**	**13%**	**33%**	**8%**	
Natural & Applied Science / Health Occupations	2,138	10%	Occasionally	11%	4%	9%	12%	5%	2%	C, D
			Freq./Always	4%	1%	11%	15%	39%	12%	
			Any	**15%**	**5%**	**21%**	**27%**	**44%**	**14%**	
Managers / Prof. Business Occupations	3,252	14%	Occasionally	11%	---	18%	---	7%	---	A, B0
			Freq./Always	6%	---	38%	---	55%	---	
			Any	**17%**	---	**55%**	---	**63%**	---	

[a] Each occupational category excludes employees in locations with 10 employees or less because the question on job rotation, problem-solving teams, and self-directed workgroups are not asked of these employees and their employers.

[b] Except for the number of observations, all other figures in Table 1 are weighted.

[c] *Informal* denotes a work practice that the employer respondent says does not "formally exist" in the location for non-managerial employees.

[d] *Formal* denotes a work practice that the employer respondent says "formally exist" in the location.

[e] The Canadian National Occupational Classification system is at http://www.statcan.ca/english/concepts/occupation.htm.

Table 2
Increased Skill Requirements since the Start of the Job, 1999

	Shop-Floor		Office		Science and Health	
Variable	***Coefficient***	***Standard Error***	***Coefficient***	***Standard Error***	***Coefficient***	***Standard Error***
Formal Job Rotation	0.023	(0.134)	0.440***	(0.135)	0.508***	(0.181)
Informal Job Rotation	0.066	(0.062)	0.196**	(0.083)	0.136	(0.117)
Formal Problem-solving Teams	0.278***	(0.059)	0.340***	(0.099)	0.163**	(0.082)
Informal Problem-solving Teams	0.184***	(0.068)	0.161**	(0.064)	0.178*	(0.093)
Formal Self-Directed Workgroups	0.166***	(0.056)	0.125*	(0.074)	0.093	(0.073)
Flexible Job Design—Location	0.142	(0.124)	-0.020	(0.110)	-0.187	(0.139)
Prob.-Solving Teams—Location	0.268**	(0.105)	0.157	(0.114)	-0.111	(0.168)
Self-Directed Workgroup—Location	-0.025	(0.126)	-0.223	(0.149)	0.183	(0.150)
Technology More Complex	1.207***	(0.084)	1.034***	(0.089)	1.260***	(0.102)
Uses a Computer	0.179*	(0.099)	0.395**	(0.182)	0.246	(0.169)
Uses a Computer Controlled Device	-0.054	(0.104)	-0.215	(0.176)	-0.027	(0.171)
Uses Other Device	0.229**	(0.091)	0.358***	(0.130)	0.266*	(0.152)
Job Tenure	0.052	(0.033)	0.134***	(0.036)	0.212***	(0.056)
Job Tenure Squared / 100	-0.227	(0.245)	-0.885***	(0.297)	-1.269***	(0.475)
Job Tenure Cubed / 1000	0.039	(0.048)	0.168**	(0.065)	0.250**	(0.108)
Contingent Worker	-0.657***	(0.148)	0.191	(0.193)	-0.485***	(0.167)
Part-Time Worker	---		-0.675***	(0.135)	0.507***	(0.174)
Supervisory Responsibilities	0.531***	(0.111)	0.231**	(0.108)	0.312**	(0.131)
Female	-0.190*	(0.112)	Base		-0.394***	(0.148)
Male	Base		-0.045	(0.112)	Base	
Collective Bargaining Agreement	-0.348***	(0.099)	-0.142	(0.120)	0.251	(0.177)
No H.S. Diploma or other Education	0.044	(0.108)	-0.069	(0.180)	-0.871**	(0.359)
Only a H.S Diploma	Base		Base		0.162	(0.169)
Vocational Diploma	-0.030	(0.111)	0.155	(0.135)	0.395**	(0.171)
Industry Certified Training	0.029	(0.195)	0.571**	(0.236)	0.780***	(0.300)
Some College (no College Degree)	0.158	(0.130)	-0.079	(0.119)	0.609***	(0.204)
College Degree	0.516***	(0.145)	0.347***	(0.120)	Base	
Some University (no Degree)	---		-0.152	(0.148)	0.072	(0.201)
Bachelors Degree	---		-0.086	(0.139)	0.175	(0.130)
Post-Graduate Degree	---		---		0.241	(0.215)
Any University	-0.173	(0.187)	---		---	
Size 11-20 employees	-0.305	(0.200)	0.202	(0.144)	-0.465**	(0.226)
Size 21-50 employees	-0.217	(0.139)	-0.134	(0.125)	-0.461**	(0.192)
Size 51-100 employees	-0.283*	(0.155)	0.203	(0.126)	0.220	(0.216)
Size 101-500 employees	Base		Base		Base	
Size over 500 employees	-0.280**	(0.136)	0.461***	(0.123)	0.161	(0.170)
Multi Establishment Location	0.214**	(0.101)	-0.156*	(0.081)	-0.223*	(0.116)
Dummies for Industry Categories	Yes		Yes		Yes	
Dummies for Occupation Categories	Yes		Yes		Yes	
Regression Type	Binary Logit		Binary Logit		Binary Logit	
Observations	2,860		4,310		2,138	

Note: *Coefficient Significant at 10%; **Coefficient Significant at 5%; ***Coefficient Significant at 1%

Table 3
The probability of Increased Skill Requirements Since the Start of the Job, 1999

Variable	Variable=0	Variable=1	Variable=2	Variable=3
Shop-Floor				
Formal Job Rotation	42%	42%	42%	---
Informal Job Rotation	42%	42%	42%	---
Formal Problem-solving Teams	44%	50%***	57%***	---
Informal Problem-solving Teams	37%	41%***	46%***	---
Formal Self-Directed Workgroups	42%	46%***	50%***	55%***
More Complex Technology	30%	59%**	---	---
Office				
Formal Job Rotation	64%	73%***	81%***	---
Informal Job Rotation	64%	68%**	72%**	---
Formal Problem-solving Teams	62%	69%***	76%***	---
Informal Problem-solving Teams	62%	66%**	69%**	---
Formal Self-Directed Workgroups	66%	69%*	71%*	74%*
More Complex Technology	49%	73%**	---	---
Science and Health				
Formal Job Rotation	68%	78%***	85%***	---
Informal Job Rotation	68%	68%	68%	---
Formal Problem-solving Teams	67%	70%**	74%**	---
Informal Problem-solving Teams	67%	71%*	74%*	---
Formal Self-Directed Workgroups	67%	67%	67%	67%
More Complex Technology	47%	76%**	---	---

Note: When the underlying coefficient is not significant at the 10% level, it is assumed that it does not affect the probability of increased skill requirements; *Underlying Coefficient Significant at 10%; **Underlying Coefficient Significant at 5%; ***Underlying Coefficient Significant at 1%; The probabilities are calculated at the mean of the other variables; For all work practice variables, variable=0 implies never participates and variable=1 implies occasionally participates; For job rotation and self-directed workgroups, variable=2 implies frequently participates; For problem-solving teams, variable=2 implies either frequently or always participates; For self-directed work-groups, variable=3 implies always participates.

Table 4
Taken Classroom Training in the Last 12 Months, 1999

	Shop-Floor		Office		Science and Health	
Variable	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
Formal Job Rotation	0.016	(0.113)	0.372***	(0.123)	0.581***	(0.215)
Informal Job Rotation	0.534***	(0.076)	0.171**	(0.074)	0.244**	(0.103)
Formal Problem-solving Teams	0.299***	(0.067)	0.047	(0.101)	0.337***	(0.081)
Informal Problem-solving Teams	0.437***	(0.105)	0.134*	(0.070)	0.001	(0.093)
Formal Self-Directed Workgroups	-0.174***	(0.056)	-0.028	(0.075)	-0.036	(0.064)
Flexible Job Design—Location	0.328***	(0.123)	0.019	(0.096)	0.442***	(0.134)
Prob.-Solving Teams—Location	0.521***	(0.132)	0.175	(0.126)	-0.031	(0.169)
Self-Directed Workgroup—Location	0.369**	(0.150)	0.175	(0.132)	0.039	(0.142)
Uses a Computer	1.059***	(0.114)	0.194	(0.218)	-0.013	(0.207)
Uses a Computer Controlled Device	0.219	(0.158)	-0.434**	(0.177)	-0.108	(0.188)
Upgrade in a Computer Controlled	0.746***	(0.208)	0.222	(0.244)	0.448*	(0.270)
Uses Other Device	-0.282**	(0.126)	0.109	(0.132)	0.250*	(0.133)
Upgrade in Other Device	0.047	(0.196)	0.501**	(0.205)	-0.366*	(0.213)
Job Tenure	-0.008	(0.039)	-0.013	(0.031)	0.011	(0.037)
Job Tenure Squared / 100	-0.059	(0.289)	-0.189	(0.240)	-0.049	(0.280)
Job Tenure Cubed / 1000	0.027	(0.056)	0.019	(0.048)	-0.022	(0.057)
Contingent Worker	-0.233	(0.253)	-1.516***	(0.198)	-0.647***	(0.160)
Part-Time Worker	---		-0.667***	(0.175)	0.382***	(0.130)
Supervisory Responsibilities	-0.173	(0.142)	0.238**	(0.105)	0.052	(0.115)
Female	-0.587***	(0.152)	Base		0.040	(0.143)
Male	Base		-0.09.	(0.100)	Base	
Age	0.015	(0.034)	0.035	(0.028)	0.013	(0.047)
Age Squared / 100	-0.034	(0.041)	-0.037	(0.036)	-0.020	(0.056)
Collective Bargaining Agreement	-0.129	(0.129)	0.218	(0.134)	0.307**	(0.141)
No H.S. Diploma or other Education	-0.103	(0.148)	0.237	(0.172)	0.234	(0.300)
Only a H.S Diploma	Base		Base		0.400**	(0.169)
Vocational Diploma	0.390***	(0.119)	-0.034	(0.141)	0.004	(0.182)
Industry Certified Training	0.137	(0.241)	0.838***	(0.241)	-0.503***	(0.176)
Some College (no College Degree)	0.475***	(0.150)	0.286***	(0.107)	0.608***	(0.201)
College Degree	0.120	(0.145)	0.578***	(0.097)	Base	
Some University (no Degree)	---		0.066	(0.149)	-0.143	(0.191)
Bachelors Degree	---		0.289**	(0.116)	0.215	(0.137)
Post-Graduate Degree	---		---		-0.172	(0.173)
Any University	0.719***	(0.207)	---		---	
Size 11-20 employees	-0.740***	(0.225)	-0.675***	(0.149)	-1.318***	(0.313)
Size 21-50 employees	-0.370**	(0.175)	-0.665***	(0.123)	-0.376*	(0.211)
Size 51-100 employees	-0.311*	(0.182)	-0.366***	(0.129)	0.414**	(0.168)
Size 101-500 employees	Base		Base		Base	
Size over 500 employees	0.217	(0.134)	0.210*	(0.127)	0.259*	(0.142)
Multi Establishment Location	-0.090	(0.120)	0.289***	(0.075)	0.030	(0.128)
Dummies for Industry Categories	Yes		Yes		Yes	
Dummies for Occupation Categories	Yes		Yes		Yes	
Regression Type	Binary Logit		Binary Logit		Binary Logit	
Observations	2,860		4,310		2,138	

Note: *Coefficient Significant at 10%; **Coefficient Significant at 5%; ***Coefficient Significant at 1%

Table 5
The Probability of Having Taken Classroom Training in the Last 12 Months, 1999

Variable	Variable=0	Variable=1	Variable=2	Variable=3
Shop-Floor Employees				
Formal Job Rotation	17%	17%	17%	---
Informal Job Rotation	13%	20%***	30%***	---
Formal Problem-solving Teams	17%	21%***	27%***	---
Informal Problem-solving Teams	11%	18%***	22%***	---
Formal Self-Directed Workgroups	21%	18%***	16%***	14%***
Uses a Computer	11%	27%***	---	---
Uses a Computer Controlled Device	15%	15%	---	---
Upgrade in a Computer Controlled	15%	26%***	---	---
Uses Other Device	17%	13%**	---	---
Upgrade in Other Device	13%	13%	---	---
Office Employees				
Formal Job Rotation	33%	42%***	51%***	---
Informal Job Rotation	33%	37%**	41%**	---
Formal Problem-solving Teams	33%	33%	33%	---
Informal Problem-solving Teams	33%	36%*	39%*	---
Formal Self-Directed Workgroups	35%	35%	35%	35%
Uses a Computer	31%	31%	---	---
Uses a Computer Controlled Device	36%	27%**	---	---
Upgrade in a Computer Controlled	26%	26%	---	---
Uses Other Device	35%	35%	---	---
Upgrade in Other Device	34%	46%**	---	---
Science/Health Employees				
Formal Job Rotation	54%	68%***	79%***	---
Informal Job Rotation	43%	50%**	56%**	---
Formal Problem-solving Teams	45%	54%***	62%***	---
Informal Problem-solving Teams	45%	45%	45%	---
Formal Self-Directed Workgroups	49%	49%	49%	49%
Uses a Computer	49%	49%	---	---
Uses a Computer Controlled Device	49%	49%	---	---
Upgrade in a Computer Controlled	48%	59%*	---	---
Uses Other Device	47%	53%*	---	---
Upgrade in Other Device	54%	44%*	---	---

Note: When the underlying coefficient is not significant at the 10% level, it is assumed that it does not affect the probability of enrollment in training; *Underlying Coefficient Significant at 10%; **Underlying Coefficient Significant at 5%; ***Underlying Coefficient Significant at 1%; The probabilities are calculated at the mean of the other variables; For all work practice variables, variable=0 implies never participates and variable=1 implies occasionally participates; For job rotation and self-directed workgroups, variable=2 implies frequently participates; For problem-solving teams, variable=2 implies either frequently or always participates; For self-directed work-groups, variable=3 implies always participates.

Table 6
Taken On-the-Job Training in the Last 12 Months, 1999

	Shop-Floor		Office		Science and Health	
Variable	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
Formal Job Rotation	-0.262**	(0.114)	0.097	(0.113)	-0.082	(0.146)
Informal Job Rotation	0.260**	(0.114)	0.554***	(0.066)	0.202*	(0.113)
Formal Problem-solving Teams	0.039	(0.075)	-0.295***	(0.086)	0.013	(0.081)
Informal Problem-solving Teams	0.269***	(0.095)	0.013	(0.080)	0.181*	(0.103)
Formal Self-Directed Workgroups	-0.107	(0.089)	-0.030	(0.064)	-0.003	(0.083)
Flexible Job Design—Location	0.019	(0.141)	0.053	(0.105)	0.253*	(0.140)
Prob.-Solving Teams—Location	-0.106	(0.122)	0.165	(0.111)	0.396**	(0.183)
Self-Directed Workgroup—Location	0.586***	(0.191)	0.539***	(0.135)	-0.092	(0.185)
Uses a Computer	0.728***	(0.112)	0.449**	(0.212)	-0.236	(0.177)
Uses a Computer Controlled Device	0.153	(0.132)	0.509**	(0.205)	0.243	(0.231)
Upgrade in a Computer Controlled	0.542***	(0.180)	0.545**	(0.253)	-0.514**	(0.249)
Uses Other Device	0.351***	(0.111)	-0.009	(0.127)	0.800***	(0.134)
Upgrade in Other Device	-0.303	(0.228)	0.727***	(0.219)	-0.864***	(0.193)
Job Tenure	-0.267***	(0.044)	-0.194***	(0.031)	-0.106***	(0.039)
Job Tenure Squared / 100	1.888***	(0.351)	1.174***	(0.272)	0.608**	(0.301)
Job Tenure Cubed / 1000	-0.373***	(0.073)	-0.215***	(0.060)	-0.065	(0.060)
Contingent Worker	-1.214***	(0.239)	0.067	(0.194)	-0.549***	(0.180)
Part-Time Worker	---		-0.218	(0.167)	0.327*	(0.171)
Supervisory Responsibilities	-0.386***	(0.118)	0.030	(0.096)	0.240**	(0.103)
Female	0.222	(0.154)	Base		-0.255*	(0.134)
Male	Base		-0.302***	(0.112)	Base	
Age	0.100***	(0.036)	0.061*	(0.034)	0.135***	(0.048)
Age Squared / 100	-0.150***	(0.046)	-0.053	(0.041)	-0.195***	(0.058)
Collective Bargaining Agreement	0.135	(0.102)	-0.070	(0.114)	0.261**	(0.128)
No H.S. Diploma or other Education	0.135	(0.117)	0.106	(0.211)	0.632*	(0.330)
Only a H.S Diploma	Base		Base		-0.531**	(0.224)
Vocational Diploma	0.345***	(0.120)	0.060	(0.143)	0.025	(0.179)
Industry Certified Training	0.138	(0.171)	0.534***	(0.176)	-0.043	(0.204)
Some College (no College Degree)	0.200	(0.166)	0.079	(0.137)	0.102	(0.237)
College Degree	0.189	(0.146)	0.009	(0.106)	Base	
Some University (no Degree)	---		-0.155	(0.112)	0.093	(0.182)
Bachelors Degree	---		0.379***	(0.120)	-0.209	(0.140)
Post-Graduate Degree	---		---		-0.024	(0.213)
Any University	0.575***	(0.169)	---		---	
Size 11-20 employees	0.225	(0.232)	-0.052	(0.152)	-0.197	(0.266)
Size 21-50 employees	0.111	(0.184)	0.046	(0.117)	-0.649***	(0.237)
Size 51-100 employees	0.596***	(0.187)	0.338**	(0.139)	0.619***	(0.175)
Size 101-500 employees	Base		Base		Base	
Size over 500 employees	0.570***	(0.124)	-0.101	(0.107)	0.430***	(0.144)
Multi Establishment Location	0.016	(0.119)	0.315***	(0.082)	-0.135	(0.123)
Dummies for Industry Categories	Yes		Yes		Yes	
Dummies for Occupation Categories	Yes		Yes		Yes	
Regression Type	Binary Logit		Binary Logit		Binary Logit	
Observations	2,860		4,310		2,138	

Note: *Coefficient Significant at 10%; **Coefficient Significant at 5%; ***Coefficient Significant at 1%

Table 7
The Probability of Having Taken On-the-Job Training in the Last 12 Months, 1999

Variable	Variable=0	Variable=1	Variable=2	Variable=3
Shop-Floor Employees				
Formal Job Rotation	20%	16%**	13%**	---
Informal Job Rotation	20%	24%**	29%**	---
Formal Problem-solving Teams	20%	20%	20%	---
Informal Problem-solving Teams	20%	24%***	29%***	---
Formal Self-Directed Workgroups	31%	31%	31%	31%
Uses a Computer	17%	30%***	---	---
Uses a Computer Controlled Device	20%	20%	---	---
Upgrade in a Computer Controlled	20%	30%***	---	---
Uses Other Device	19%	25%***	---	---
Upgrade in Other Device	25%	25%	---	---
Office Employees				
Formal Job Rotation	25%	25%	25%	---
Informal Job Rotation	25%	37%***	50%***	---
Formal Problem-solving Teams	28%	22%***	18%***	---
Informal Problem-solving Teams	28%	28%	28%	---
Formal Self-Directed Workgroups	38%	38%	38%	38%
Uses a Computer	21%	29%**	---	---
Uses a Computer Controlled Device	27%	38%**	---	---
Upgrade in a Computer Controlled	38%	51%**	---	---
Uses Other Device	28%	28%	---	---
Upgrade in Other Device	27%	44%***	---	---
Science/Health Employees				
Formal Job Rotation	36%	36%	36%	---
Informal Job Rotation	30%	34%*	39%*	---
Formal Problem-solving Teams	35%	35%	35%	---
Informal Problem-solving Teams	27%	30%*	34%*	---
Formal Self-Directed Workgroups	33%	33%	33%	33%
Uses a Computer	36%	36%	---	---
Uses a Computer Controlled Device	31%	31%	---	---
Upgrade in a Computer Controlled	32%	22%**	---	---
Uses Other Device	28%	47%***	---	---
Upgrade in Other Device	48%	28%***	---	---

Note: When the underlying coefficient is not significant at the 10% level, it is assumed that it does not affect the probability of enrollment in training; *Underlying Coefficient Significant at 10%; **Underlying Coefficient Significant at 5%; ***Underlying Coefficient Significant at 1%; The probabilities are calculated at the mean of the other variables; For all work practice variables, variable=0 implies never participates and variable=1 implies occasionally participates; For job rotation and self-directed workgroups, variable=2 implies frequently participates; For problem-solving teams, variable=2 implies either frequently or always participates; For self-directed work-groups, variable=3 implies always participates.

Table 8
Taken Classroom Training in the Last 12 Months, 2000

	Shop-Floor		Office		Science and Health	
Variable	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
Formal Job Rotation—99 & 00	-0.174	(0.157)	0.347*	(0.203)	0.777***	(0.258)
Formal Job Rotation—00 only	-0.044	(0.219)	0.828***	(0.194)	0.034	(0.200)
Informal Job Rotation—99 & 00	0.141	(0.127)	0.186	(0.124)	0.572***	(0.207)
Informal Job Rotation —00 only	0.249*	(0.140)	-0.003	(0.132)	-0.479***	(0.159)
Formal P.S. Teams—99 & 00	0.239***	(0.087)	0.635***	(0.104)	0.062	(0.098)
Formal P.S. Teams—00 only	-0.351**	(0.155)	0.365***	(0.101)	-0.461***	(0.151)
Informal P.S. Teams—99 & 00	-0.010	(0.101)	0.257***	(0.094)	0.127	(0.107)
Informal P.S. Teams—00 only	-0.194	(0.177)	0.362***	(0.127)	0.218*	(0.130)
Formal S.D. Workgroups—99 & 00	0.310***	(0.092)	-0.356***	(0.107)	-0.088	(0.085)
Formal S.D. Workgroups—00 only	0.298**	(0.130)	-0.204	(0.128)	0.057	(0.113)
Flexible Job Design—Location	0.287**	(0.138)	0.015	(0.139)	-0.289**	(0.135)
Prob.-Solving Teams—Location	0.300**	(0.146)	-0.116	(0.153)	0.433**	(0.169)
Self-Directed Workgroup—Location	-0.173	(0.179)	0.377*	(0.202)	-0.411**	(0.184)
Uses a Computer	0.274*	(0.145)	0.434**	(0.186)	0.139	(0.163)
Uses a Computer Controlled Device	0.058	(0.194)	-0.160	(0.235)	0.144	(0.198)
Upgrade in a Computer Controlled	0.396	(0.256)	0.432	(0.326)	0.538*	(0.284)
Uses Other Device	0.259	(0.168)	0.435***	(0.106)	-0.225	(0.161)
Upgrade in Other Device	0.316	(0.268)	0.309*	(0.183)	0.508**	(0.235)
Job Tenure	0.132**	(0.056)	-0.094**	(0.046)	-0.066	(0.045)
Job Tenure Squared / 100	-1.037***	(0.392)	0.341	(0.361)	0.354	(0.323)
Job Tenure Cubed / 1000	0.223***	(0.074)	-0.072	(0.073)	-0.066	(0.064)
Contingent Worker	0.860***	(0.301)	0.697**	(0.322)	-0.869***	(0.317)
Part-Time Worker	---		-0.789***	(0.209)	-0.068	(0.190)
Supervisory Responsibilities	0.336**	(0.154)	-0.202*	(0.111)	-0.187	(0.145)
Female	0.055	(0.174)	Base		0.249	(0.159)
Male	Base		-0.183	(0.131)	Base	
Age	0.046	(0.054)	0.022	(0.040)	-0.007	(0.048)
Age Squared / 100	-0.070	(0.064)	-0.031	(0.048)	-0.006	(0.059)
Collective Bargaining Agreement	-0.774***	(0.167)	0.315**	(0.123)	0.506***	(0.193)
No H.S. Diploma or other Education	-0.193	(0.160)	-0.784***	(0.237)	0.054	(0.296)
Only a H.S Diploma	Base		Base		0.129	(0.224)
Vocational Diploma	0.301*	(0.162)	0.194	(0.150)	-0.090	(0.218)
Industry Certified Training	-0.311	(0.248)	-0.374*	(0.223)	-0.058	(0.236)
Some College (no College Degree)	-0.075	(0.213)	-0.165	(0.149)	0.260	(0.286)
College Degree	0.154	(0.173)	0.410***	(0.131)	Base	
Some University (no Degree)	---		-0.172	(0.131)	0.079	(0.169)
Bachelors Degree	---		-0.024	(0.182)	0.245	(0.151)
Post-Graduate Degree	---		---		0.344	(0.246)
Any University	0.122	(0.241)	---		---	
Size 11-20 employees	-2.898***	(0.536)	-1.089***	(0.227)	-0.232	(0.364)
Size 21-50 employees	-1.411***	(0.244)	-0.858***	(0.145)	-0.297	(0.235)
Size 51-100 employees	-1.157***	(0.252)	-0.294*	(0.174)	0.538***	(0.193)
Size 101-500 employees	Base		Base		Base	
Size over 500 employees	0.184	(0.141)	0.064	(0.149)	-0.092	(0.141)
Multi Establishment Location	0.202	(0.155)	-0.169	(0.111)	0.122	(0.143)
Dummies for Industry Categories	Yes		Yes		Yes	
Dummies for Occupation Categories	Yes		Yes		Yes	
Regression Type	Binary Logit		Binary Logit		Binary Logit	
Observations	1,971		2,885		1,525	

Note: *Coefficient Significant at 10%; **Coefficient Significant at 5%; ***Coefficient Significant at 1%

Table 9
Taken On-the-Job Training in the Last 12 Months, 2000

	Shop-Floor		Office		Science and Health	
Variable	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
Formal Job Rotation—99 & 00	-0.198	(0.153)	0.415***	(0.150)	0.890***	(0.251)
Formal Job Rotation—00 only	-0.092	(0.220)	0.344*	(0.204)	-0.240	(0.277)
Informal Job Rotation—99 & 00	1.005***	(0.125)	0.143	(0.112)	1.792***	(0.380)
Informal Job Rotation —00 only	0.253	(0.222)	0.660***	(0.118)	0.327*	(0.179)
Formal P.S. Teams—99 & 00	0.403***	(0.112)	0.471***	(0.164)	0.298***	(0.093)
Formal P.S. Teams—00 only	0.301**	(0.145)	0.501***	(0.161)	0.164	(0.128)
Informal P.S. Teams—99 & 00	0.081	(0.115)	0.148	(0.093)	0.397***	(0.104)
Informal P.S. Teams—00 only	0.168	(0.146)	-0.038	(0.096)	0.129	(0.144)
Formal S.D. Workgroups—99 & 00	0.097	(0.090)	0.086	(0.104)	0.161*	(0.093)
Formal S.D. Workgroups—00 only	-0.305	(0.198)	0.095	(0.114)	-0.217	(0.138)
Flexible Job Design—Location	0.314**	(0.138)	0.114	(0.134)	-0.227*	(0.129)
Prob.-Solving Teams—Location	-0.787***	(0.192)	-0.370***	(0.132)	0.311*	(0.170)
Self-Directed Workgroup—Location	0.603***	(0.172)	0.046	(0.180)	-0.286	(0.244)
Uses a Computer	0.384**	(0.185)	0.925***	(0.231)	0.184	(0.196)
Uses a Computer Controlled Device	-0.602***	(0.213)	-0.369*	(0.195)	0.495***	(0.176)
Upgrade in a Computer Controlled	1.361***	(0.235)	1.711***	(0.323)	-0.064	(0.243)
Uses Other Device	-0.564***	(0.211)	0.318**	(0.144)	-0.174	(0.154)
Upgrade in Other Device	1.557***	(0.303)	0.373*	(0.220)	1.453***	(0.272)
Job Tenure	-0.085	(0.062)	-0.029	(0.045)	-0.020	(0.055)
Job Tenure Squared / 100	0.486	(0.440)	0.048	(0.345)	0.311	(0.380)
Job Tenure Cubed / 1000	-0.089	(0.086)	-0.002	(0.063)	-0.082	(0.075)
Contingent Worker	-0.453	(0.329)	-0.268	(0.320)	-1.175***	(0.294)
Part-Time Worker	---		0.048	(0.225)	-0.069	(0.163)
Supervisory Responsibilities	0.602***	(0.183)	-0.073	(0.146)	0.082	(0.140)
Female	-0.184	(0.172)	Base		0.412***	(0.148)
Male	Base		-0.335**	(0.139)	Base	
Age	0.090*	(0.051)	0.064	(0.045)	0.156***	(0.054)
Age Squared / 100	-0.174**	(0.068)	-0.057	(0.054)	-0.190***	(0.065)
Collective Bargaining Agreement	-0.272**	(0.129)	-0.182	(0.144)	-0.174	(0.192)
No H.S. Diploma or other Education	-0.517***	(0.175)	-0.020	(0.202)	0.158	(0.431)
Only a H.S Diploma	Base		Base		-0.107	(0.229)
Vocational Diploma	0.080	(0.172)	-0.080	(0.156)	0.144	(0.238)
Industry Certified Training	-0.161	(0.196)	0.351*	(0.212)	0.291	(0.243)
Some College (no College Degree)	-0.381*	(0.203)	0.083	(0.155)	-0.160	(0.309)
College Degree	-0.008	(0.218)	0.279*	(0.159)	Base	
Some University (no Degree)	---		0.162	(0.152)	0.048	(0.198)
Bachelors Degree	---		0.437***	(0.153)	0.106	(0.154)
Post-Graduate Degree	---		---		0.363	(0.263)
Any University	0.875***	(0.224)	---		---	
Size 11-20 employees	-0.341	(0.313)	-0.477**	(0.194)	0.425	(0.273)
Size 21-50 employees	0.156	(0.165)	-0.101	(0.137)	-0.784***	(0.214)
Size 51-100 employees	0.318*	(0.178)	0.125	(0.158)	0.792***	(0.169)
Size 101-500 employees	Base		Base		Base	
Size over 500 employees	0.349***	(0.135)	0.195	(0.138)	-0.040	(0.136)
Multi Establishment Location	0.242*	(0.146)	0.377***	(0.107)	0.062	(0.130)
Dummies for Industry Categories	Yes		Yes		Yes	
Dummies for Occupation Categories	Yes		Yes		Yes	
Regression Type	Binary Logit		Binary Logit		Binary Logit	
Observations	1,971		2,885		1,525	

Note: *Coefficient Significant at 10%; **Coefficient Significant at 5%; ***Coefficient Significant at 1%

Appendix I

Employer and Employee Questions on Job Rotation, Problem-Solving Teams and Self-Directed Work-Groups

The Employee Questionnaire

Over the telephone, the interviewer reads the following passage before asking the questions:

> The next few questions deal with employee participation in decisions regarding the workplace. Please report how frequently this statement applies to you. Although a program or policy may exist somewhere in your workplace, we are only interested in those that apply directly to you. If the answer to any of questions 31 (a) to 31 (d) is 'always', answer 'frequently'.

Question 31 (c): Do you participate in a job rotation or cross-training program where you work or are trained on a job with different duties than your regular job? *Never, Occasionally, Frequently.*

Question 31 (f): Do you participate in a team or circle concerned with quality or work flow issues? *Never, Occasionally, Frequently, Always.*

Question 31 (g): Are you part of a self-directed work group (or semi-autonomous work group or mini-enterprise group) that has a high level of responsibility for a particular product or service area? In such systems, part of your pay is normally related to group performance. *Never, Occasionally, Frequently, Always*
(Self-directed work groups:

- Are responsible for production of a fixed product or service, and have a high degree of autonomy in how they organize themselves to produce that product or service.
- Act almost as "businesses within businesses".
- Often have incentives related to productivity, timeliness and quality.
- While most have a designated leader, other members also contribute to the organization of the group's activities.) *Note: The portion in brackets is read only if the respondent asks for further clarification. No record was kept of how many employees were actually read the portion in brackets.*

The Employer Questionnaire

In this face-to-face interview,[20] the respondent for the employer is asked: "For non-managerial employees, which of the following practices exist on a formal basis in your workplace? In what year were they implemented?"

The interviewer then asks about the following practices as parts of question number 18 in the WES employer survey:

Part B: Flexible job design. Includes job rotation, job enrichment/redesign (broadened job definitions), job enrichment (increased skills, variety or autonomy of work). *Yes or No*

Part D: Problem-solving teams. Responsibilities of teams are limited to specific areas such as quality or work flow (i.e., narrower range of responsibilities than F). *Yes or No*

Part F: Self-directed work groups. Semi-autonomous work groups or mini-enterprise work groups that have a high level of responsibility for a wide range of decisions / issues. *Yes or No*

[20] Employers with 10 or fewer employees were interviewed over the telephone and were also not asked these questions on work organization.

Appendix II

Employee Questions on Job-Related Training Provided or Paid by the Employer

Over the telephone, the interviewer states that "the next few questions deal with job-related training provided or paid by your employer" and then immediately asks the question: "In the past twelve months, have you received any classroom training related to your job?" If the respondent indicates that they took some classroom training, the interviewer then asks the number of courses taken. For the last and second courses taken, the interviewer also asks the time spent in training sessions and the *main* subject out of thirteen choices orientation for new employees; managerial and supervisory; professional; apprenticeship; sales and marketing; computer hardware; computer software; other office or non-office equipment; group decision-making or problem-solving; team building, leadership, communication; occupational health and safety and environmental protection; literacy or numeracy; and other training.[21]

After the series of question on employer-provided classroom training, the interviewer asks about on-the-job training: "In the past twelve months, have you received any informal training related to your job (that is on-the-job training)?" For on-the-job training, employees are asked about the total time spent in training sessions and the *main subjects* of that training (from the same thirteen choices available for classroom training).

[21] The fact that the survey asks employees to indicate only one main subject for each course may be excessively restrictive.

Appendix III

Definitions of Selected Independent Variables Used in this Study	
Variable	**Definition**
Increased Technological Complexity	Since the start of the job, has the overall technological complexity increased?
Uses a Computer	Do you use a computer in your job? (Excludes sales terminals, scanners, machine monitors, etc.)
Uses a Computer Controlled Device	Do you use a computer-controlled or computer-assisted technology in the course of your normal duties? (For example, industrial robots, retail scanning systems, CAD/CAM systems)
Upgrade in a Computer Controlled Device	Has there been an upgrade or change in that technology in the past 12 months?
Uses Other Device	Do you use any other machine or technological device for at least one hour a day in the course of your normal duties? (This question is meant to be inclusive and would include, for example, cash registers, sales terminals scanners, manual typewriters, industrial machinery and vehicles.)
Upgrade in Other Device	Has there been an upgrade or change in that technology in the past 12 months?
Job Tenure	Calculated based on the date when the employee started working at this particular job
Contingent Worker	The employee reports that he or she is not a regular employee with any contractual or anticipated termination date.
Part-Time Worker	Works less than 30 hours per week
Supervisory Responsibilities	Do you supervise the work of other employees on a day-to-day basis?
Collective Bargaining Agreement	In your current job, are you a member of a union or covered by a collective bargaining agreement?
No High School Diploma or other education	Did not graduate from high school (secondary school)
Only a High School Diploma	Graduated from high school, but did not take any further post-secondary education
Vocational Diploma	Has a trade or vocational diploma or certificate.
Some College	Has some college, CEGEP, Institute of technology or Nursing school, but did not complete
College Degree	Has completed college, CEGEP, Institute of technology or Nursing school.
Some University	Has some university or university certificate or diploma below the bachelor level, but no bachelor's level degree.
Bachelors	Bachelor or undergraduate degree or teacher's college
Post-Graduate Degree	A post-secondary degree beyond the bachelor's level. Must also have a bachelor's degree.
Any University	Has some university (as defined above) or a bachelor's degree. This variable is used for the shop-floor employee sample only.
Size (5 categories)	Based on the number of people employed in the location in the last pay period of March the year of the survey.
Multi Establishment Location	Location is part of a multi-establishment enterprise—The Data for this question comes from the Business Register and not from WES.

Appendix IV

Variable Means, 1999			
	Shop-Floor	Office	Science/Health
Dummy Variables (Means are proportions)			
Increased Skill Requirements	0.448	0.633	0.626
Enrolled in Classroom Training	0.235	0.382	0.489
Enrolled in On-the-Job Training	0.262	0.306	0.347
Formal Job Rotation	0.099	0.102	0.062
Informal Job Rotation	0.312	0.220	0.182
Formal Problem-solving Teams	0.281	0.203	0.416
Informal Problem-solving Teams	0.366	0.279	0.324
Formal Self-Directed Workgroups	0.223	0.210	0.359
Flexible Job Design—Location	0.248	0.272	0.268
Prob.-Solving Teams—Location	0.386	0.348	0.511
Self-Directed Workgroup—Location	0.156	0.186	0.233
Technology More Complex	0.481	0.658	0.700
Uses a Computer	0.350	0.913	0.715
Uses a Computer Controlled Device	0.189	0.071	0.151
Upgrade in a Computer Controlled	0.073	0.035	0.090
Uses Other Device	0.348	0.178	0.238
Upgrade in Other Device	0.099	0.038	0.082
Contingent Worker	0.038	0.049	0.110
Part-Time Worker	---	0.101	0.170
Supervisory Responsibilities	0.314	0.267	0.399
Female	0.226	0.252	0.421
Male	0.774	0.748	0.579
Collective Bargaining Agreement	0.438	0.243	0.435
No H.S. Diploma or other Education	0.283	0.072	0.031
Only a H.S Diploma	0.276	0.262	0.109
Vocational Diploma	0.180	0.099	0.087
Industry Certified Training	0.052	0.024	0.037
Some College (no College Degree)	0.099	0.148	0.072
College Degree	0.109	0.290	0.443
Some University (no Degree)	---	0.115	0.094
Bachelors Degree	---	0.104	0.296
Post-Graduate Degree	---	---	0.095
Any University	0.100	---	---
Size 11-20 employees	0.068	0.154	0.063
Size 21-50 employees	0.164	0.199	0.099
Size 51-100 employees	0.119	0.122	0.146
Size 101-500 employees	0.388	0.282	0.267
Size over 500 employees	0.261	0.243	0.425
Multi Establishment Location	0.485	0.455	0.497
Continuous Variables			
Job Tenure (in years)	7.290	6.304	7.297
Job Tenure Squared / 100 (in years)	1.115	0.868	1.063
Job Tenure Cubed / 1000 (in years)	2.417	1.773	2.116
Age (in years)	40.34	40.18	40.69
Age Squared / 100 (in years)	17.32	17.13	17.43
Observations	2,860	4,310	2,138

Variable Means, 2000			
	Shop-Floor	Office	Science/Health
Dummy Variables (Means are proportions)			
Enrollment in Classroom Training	0.196	0.346	0.489
Enrollment in On-the-Job Training	0.193	0.256	0.382
Formal Job Rotation—99 & 00	0.059	0.037	0.030
Formal Job Rotation—00 only	0.029	0.037	0.046
Informal Job Rotation—99 & 00	0.185	0.088	0.054
Informal Job Rotation —00 only	0.097	0.103	0.097
Formal P.S. Teams—99 & 00	0.212	0.119	0.290
Formal P.S. Teams—00 only	0.089	0.082	0.119
Informal P.S. Teams—99 & 00	0.166	0.172	0.230
Informal P.S. Teams—00 only	0.140	0.177	0.109
Formal S.D. Workgroups—99 & 00	0.169	0.115	0.208
Formal S.D. Workgroups—00 only	0.045	0.059	0.094
Flexible Job Design—Location	0.236	0.274	0.261
Prob.-Solving Teams—Location	0.399	0.367	0.512
Self-Directed Workgroup—Location	0.160	0.190	0.224
Uses a Computer	0.386	0.922	0.710
Uses a Computer Controlled Device	0.229	0.068	0.169
Upgrade in a Computer Controlled	0.073	0.022	0.079
Uses Other Device	0.307	0.253	0.212
Upgrade in Other Device	0.053	0.056	0.083
Contingent Worker	0.034	0.031	0.080
Part-Time Worker	---	0.089	0.149
Supervisory Responsibilities	0.284	0.291	0.374
Female	0.216	0.709	0.611
Male	0.784	0.242	0.389
Collective Bargaining Agreement	0.488	0.268	0.497
No H.S. Diploma or other Education	0.274	0.067	0.039
Only a H.S Diploma	0.279	0.304	0.095
Vocational Diploma	0.191	0.094	0.091
Industry Certified Training	0.057	0.024	0.045
Some College (no College Degree)	0.084	0.156	0.069
College Degree	0.109	0.258	0.448
Some University (no Degree)	---	0.108	0.084
Bachelors Degree	---	0.088	0.312
Post-Graduate Degree	---	---	0.094
Any University	0.115	---	---
Size 11-20 employees	0.049	0.128	0.051
Size 21-50 employees	0.159	0.198	0.079
Size 51-100 employees	0.125	0.139	0.145
Size 101-500 employees	0.377	0.267	0.259
Size over 500 employees	0.290	0.268	0.466
Multi Establishment Location	0.523	0.449	0.496
Continuous Variables			
Job Tenure (in years)	8.510	7.912	8.658
Job Tenure Squared / 100 (in years)	1.353	1.141	1.307
Job Tenure Cubed / 1000 (in years)	3.059	2.374	2.681
Age (in years)	41.048	41.100	41.035
Age Squared / 100 (in years)	17.868	17.834	17.636
Observations	1,971	2,885	1,525

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